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A comparison of a measure of crude gain with a measure of residual gain in individual reading improvement, as measured by the Nelson-Denny Reading Test, Revised, Form A and B administered to thirty-six college freshmen, showed the residual gain method to be the more reliable assessment of reading improvement. In addition, the residual gain procedure is not affected by pre-test score differences, it provides a realistic basis for grading individual reading improvement, and it estimates inferior and superior improvers in accordance with their own proficiency and progress in the improvement of reading. (MC)

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A Comparison of Individual Reading Improvement Scores on a Group of 36 Community College Freshmen as Measured by the Crude Gain Method and the Residual Gain Method

by Horst Gerard Taschow, Ph.D.

Most of the previous research investigating gains in reading over a designated period of time reports on two methods emplo yed to measure group or individual reading improvement. The two methods appear to be very similar in their procedure for both apply simple subtraction of pre-test scores from post-test scores. The first method of measuring reading gains subtracts the pre-test scores from the post-test scores and calls the differences between the two scores "crude gain". Symbolically, the formula representing crude gain is: Crude gain = $X_2 - X_1$. The second method is based on the same principle of finding the difference between post-test and pre-test scores but expresses the gain as a percentage of the initial or pre-test scores and is therefore called "percent gain". Symbolically, percent gain is represented by the formula: Percent gain = $X_2 - X_1 / X_1$.

Furthermore, research on gains in reading shows that apparently negative correlations resulted between initial and final status in reading improvement when measured by either the crude gain method or the percent gain method as evidenced by Ranson (7), Bloomer (1), Kamman(3), , Chansky and Bregman(2), Ramsey(5), and Schneyer(8).

Reviewing crude gain studies Manning and DuBois(4) observed that the negative correlations in these reading studies may simply reflect the spuriously negative correlation between initial status and crude gain. "These difficulties", commented Manning and DuBois, "which are encountered in measuring change by the absolute difference between two test scores, would probably be overcome if there were assurance that increments in scores on both initial and final test were equivalent, that the two tests have the same zero point, and the tests are valid and reliable at all levels of proficiency"(4,p.290). These assumptions, however, will ordinarily not be tenable.

Origin of the study

This study began in an effort to overcome the conventional way of measuring reading gains of college freshmen and sophomores by either the crude gain or the percent gain method. This effort was also encouraged as well as stimulated by the observations that
(1) students whose scores were lower on the pre-tests made apparently greater gains as measured by the post-tests than did students with average and above average pre-test scores, and (2) students whose scores were higher on the pre-tests made apparently less progress as measured by the post-tests than did students with lower pre-test scores.

For example, a student with a lower pre-test score may achieve a crude gain of +10 units as measured by the post-test score minus the pre-test score, while,at the same time and on the same test,a student with a higher initial score may achieve +3 units of crude gain as

measured by the post-test minus pre-test scores. It would then appear that according to Schneyer(9) poor readers are benefited more by reading training than are good readers. Such statement seemed not only to contradict common sense but also to discredit psychological expectation.

Purpose of the study

The purpose of this study was to compare reading gains made by 36 college freshmen as measured by the crude gain method and the residual gain method. The study raised the following questions:

1. Did the results of the individual reading gains made in vocabulary, comprehension, total reading, and reading rate as measured by the crude gain method differ when the same reading gains were measured by the residual gain method?

2. How did the position of the zero line or no-learning line affect individual reading gains in vocabulary, comprehension, total reading, and reading rate?

3. How did the position of the regression line affect the same gains made in the same sub-tests?

Evaluative Instrument

This study used as a criterion measure before and after instruction the Nelson-Denny Reading Test, Revised, Form A and B. To compute crude gains as well as residual gains of the 36 college freshmen the raw scores of the Nelson-Denny Reading Test were used. Since the raw scores are free from concomitant considerations of norming samples, educational grade levels, age, and sex, they were used in preference to percentile norms and grade equivalent norms in order that all students would be on an equal basis.

To compute individual reading improvement by the crude gain method, students' pre-test scores were subtracted from their post-test scores, that is, the initial and the final status have been treated according to the

formula: Crude gain= $X_2 - X_1$. Graphically, crude gain results were plotted against each other on the X and Y axes in relationship to the zero line, y = x. Considering residual gain statistics, both the computational and the graphical method were applied to determine individual gains in vocabulary, comprehension, total reading, and reading rate.

To compute residual gain, the raw score formula has been used(6): $Y.X = Y - [bX + C]$, where X = pre-test score, Y = post-test score, $C = \bar{Y} - b\bar{X}$, $b = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{N\Sigma X^2 - (\Sigma X)^2}$, $\bar{Y}$ = post-test mean, and $\bar{X}$ = pre-test mean. Using the graphical method for estimating residual gain, the following formula has been applied: $Y' = bX + C$, where Y' = predicted post-test score, $b = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{N\Sigma X^2 - (\Sigma X)^2}$, X = any arbitrary pre-test score value, and $C = \bar{Y} - b\bar{X}$. The computational method shows the predicted regression and the residual gain of the post-test scores on the pre-test scores. The graphical method shows the regression line based on the data of the computational method for the post-test scores on the pre-test scores.

Assessment of individual reading gains

The assessment of individual reading gains on the Nelson-Denny sub-tests of the 36 college freshmen is presented by the computational method in Table 1 and the graphical method in Table 2, Figures 1 to 4.

The computational method shows (1) the crude gains based on the simple differences between the pre-test and the post-test raw scores and (2) the residual gain method based on the predicted regressions of the post-test raw scores on the pre-test raw scores.

The graphical presentation of the crude gain method is based on y =x which for the purpose of discussion is called the zero line or no-learning line as shown in Table 2, Fig.1 to 4. Progress in student's proficiency is noted by a plus sign before the crude gain number and with its position

Table 1: Computation of crude and residual gain of individual student reading improvement

Students	Nelson-Denny sub-tests	Pre-raw scores	Post-raw scores	Crude gain	Regression of post-test on pre-test: Predicted	Residual gain
1	V	10	14	+ 4	17.105	- 3.105
	C	16	26	+ 10	33.287	- 7.287
	T.R.	26	40	+ 14	49.347	- 9.347
	R.R.	150	226	+ 76	369.493	-143.493
2	V	11	16	+ 5	18.144	- 2.144
	C	16	30	+ 14	33.287	- 3.287
	T.R.	27	46	+ 19	50.135	- 4.135
	R.R.	150	195	+ 45	369.493	-174.493
3	V	11	10	- 1	18.144	- 8.144
	C	16	38	+ 22	33.287	+ 4.712
	T.R.	27	48	+ 21	50.135	- 2.135
	R.R.	174	438	+264	388.802	+ 49.197
4	V	15	17	+ 2	22.300	- 5.300
	C	12	36	+ 24	31.634	+ 4.365
	T.R.	27	53	+ 26	50.135	+ 2.864
	R.R.	262	599	+337	459.601	+139.398
5	V	14	11	- 3	21.261	- 10.261
	C	14	22	+ 8	32.460	- 10.460
	T.R.	28	33	+ 5	50.923	- 17.923
	R.R.	174	299	+125	388.802	- 89.802
6	V	15	27	+ 12	22.300	+ 4.699
	C	20	32	+ 12	34.939	- 2.939
	T.R.	35	59	+ 24	56.438	+ 2.561
	R.R.	207	413	+206	415.352	- 2.352
7	V	18	33	+ 15	25.417	+ 7.582
	C	18	24	+ 6	34.113	- 10.113
	T.R.	36	57	+ 21	57.226	- .226
	R.R.	185	379	+194	397.652	- 18.652
8	V	7	33	+ 26	13.987	+ 19.012
	C	30	40	+ 10	39.071	+ .928
	T.R.	37	73	+ 36	58.014	+ 14.985
	R.R.	250	425	+175	449.947	- 24.947
9	V	15	26	+ 11	22.300	+ 3.699
	C	22	46	+ 24	35.766	+ 10.233
	T.R.	37	72	+ 35	58.014	+ 13.985
	R.R.	115	425	+310	341.334	+ 83.665
10	V	21	37	+ 16	28.534	+ 8.465
	C	16	38	+ 22	33.287	+ 4.712
	T.R.	37	75	+ 38	58.014	+ 16.985
	R.R.	161	403	+242	378.343	+ 24.656

Table 1 continued

Students	Nelson-Denny sub-tests	Pre-raw scores	Post-raw scores	Crude gain	Regression of post-test on pre-test: Predicted	Regression of post-test on pre-test: Residual gain
11	V	22	15	- 7	29.573	- 14.573
	C	16	34	+ 18	33.287	+ .712
	T.R.	38	49	+ 11	58.802	- 9.802
	R.R.	150	327	+177	369.493	- 42.493
12	V	18	25	+ 7	25.417	- .417
	C	26	38	+ 12	37.418	+ .581
	T.R.	44	63	+ 19	63.530	- .530
	R.R.	174	279	+105	388.802	-109.802
13	V	19	26	+ 7	26.456	- .456
	C	26	42	+ 16	37.418	+ 4.581
	T.R.	45	68	+ 23	64.318	+ 3.681
	R.R.	250	615	+365	449.947	+165.052
14	V	30	35	+ 5	37.886	- 2.886
	C	16	34	+ 18	33.287	+ .712
	T.R.	46	69	+ 23	65.106	+ 3.893
	R.R.	207	438	+231	415.352	+ 22.647
15	V	27	31	+ 4	34.769	- 3.769
	C	22	40	+ 18	35.766	+ 4.233
	T.R.	49	71	+ 22	67.470	+ 3.529
	R.R.	262	425	+163	459.601	- 34.601
16	V	24	31	+ 7	31.651	- .651
	C	26	42	+ 16	37.418	+ 4.581
	T.R.	50	73	+ 23	68.258	+ 4.741
	R.R.	150	269	+119	369.493	-100.493
17	V	27	34	+ 7	34.769	- .769
	C	24	36	+ 12	36.592	- .592
	T.R.	51	70	+ 19	69.046	+ .953
	R.R.	161	356	+195	378.343	- 22.343
18	V	20	34	+ 14	27.495	+ 6.504
	C	32	44	+ 12	39.897	+ 4.102
	T.R.	52	78	+ 26	69.834	+ 8.165
	R.R.	94	319	+225	324.439	- 5.439
19	V	22	39	+ 17	29.573	+ 9.426
	C	30	36	+ 6	39.071	- 3.071
	T.R.	52	75	+ 23	69.834	+ 5.165
	R.R.	226	450	+224	430.638	+ 19.361
20	V	29	28	- 1	36.847	- 8.847
	C	24	48	+ 24	36.592	+ 11.407
	T.R.	53	76	+ 23	70.622	+ 5.377
	R.R.	250	344	+ 94	449.947	-105.947

Table 1 continued

Students	Nelson-Denny sub-tests	Pre-raw scores	Post-raw scores	Crude gain	Regression of post-test on pre-test: Predicted	Regression of post-test on pre-test: Residual gain
21	V	23	27	+ 4	30.612	- 3.612
	C	30	40	+ 10	39.071	+ .928
	T. R.	53	67	+ 14	70.622	- 3.622
	R. R.	287	403	+116	479.715	- 76.715
22	V	31	35	+ 4	38.925	- 3.925
	C	26	32	+ 6	37.418	- 5.418
	T. R.	57	67	+ 10	73.773	- 6.773
	R. R.	384	511	+127	557.755	- 46.755
23	V	26	38	+ 12	33.730	+ 4.269
	C	32	34	+ 2	39.897	- 5.897
	T. R.	58	72	+ 14	74.561	- 2.561
	R. R.	468	599	+131	625.336	- 26.336
24	V	28	28	± 0	35.808	- 7.808
	C	32	26	- 6	39.897	- 13.897
	T. R.	60	54	- 6	76.137	- 22.137
	R. R.	262	599	+337	459.601	+139.398
25	V	28	33	+ 5	35.808	- 2.808
	C	34	44	+ 10	40.724	+ 3.275
	T. R.	62	77	+ 15	77.713	+ .713
	R. R.	195	226	+ 31	405.697	-179.697
26	V	31	35	+ 4	38.925	- 3.925
	C	32	30	- 2	39.897	- 9.897
	T. R.	63	65	+ 2	78.501	- 13.501
	R. R.	195	425	+230	405.697	+ 19.302
27	V	23	31	+ 8	30.612	+ .387
	C	40	42	+ 2	43.203	- 1.203
	T. R.	63	73	+ 10	78.501	- 5.501
	R. R.	161	511	+350	378.343	+132.656
28	V	33	40	+ 7	41.003	- 1.003
	C	30	40	+ 10	39.071	+ .928
	T. R.	63	80	+ 17	78.501	+ 1.498
	R. R.	140	538	+398	361.447	+176.552
29	V	26	30	+ 4	33.730	- 3.730
	C	38	38	± 0	42.376	- 4.376
	T. R.	64	68	+ 4	79.289	- 11.289
	R. R.	174	413	+239	388.802	+ 24.197
30	V	26	30	+ 4	33.730	- 3.730
	C	40	50	+ 10	43.203	+ 6.796
	T. R.	66	80	+ 14	80.865	- .865
	R. R.	207	438	+231	415.352	+ 22.647

Table 1 continued

Students	Nelson-Denny sub-tests	Pre-raw scores	Post-raw scores	Crude gain	Regression of post-test on pre-test: Predicted	Residual gain
31	V	32	40	+ 8	39.964	+ .035
	C	36	40	+ 4	41.550	- 1.550
	T. R.	68	80	+ 12	82.441	- 2.441
	R. R.	262	615	+353	459.601	+155.398
32	V	37	66	+ 29	45.159	+ 20.840
	C	34	52	+ 18	40.724	+ 11.275
	T. R.	71	118	+ 47	84.805	+ 33.194
	R. R.	161	290	+129	378.343	- 88.343
33	V	29	44	+ 15	36.847	+ 7.152
	C	46	44	- 2	45.682	- 1.682
	T. R.	75	88	+ 13	87.957	+ .042
	R. R.	174	538	+364	388.802	+149.197
34	V	28	33	+ 5	35.808	- 2.808
	C	48	36	- 12	46.508	- 10.508
	T. R.	76	69	- 7	88.754	- 19.745
	R. R.	359	461	+102	537.642	- 76.642
35	V	36	44	+ 8	44.120	- .120
	C	44	46	+ 2	44.855	+ 1.144
	T. R.	80	90	+ 10	91.896	- 1.896
	R. R.	226	499	+273	430.638	+ 68.361
36	V	40	51	+ 11	48.276	+ 2.723
	C	42	56	+ 14	44.029	+ 11.970
	T. R.	82	107	+ 25	93.472	+ 13.527
	R. R.	161	356	+195	378.343	- 22.343

Table 2: Graphical presentation of crude gain and residual gain for vocabulary, comprehension, total reading, and reading rate of individual student reading improvement.

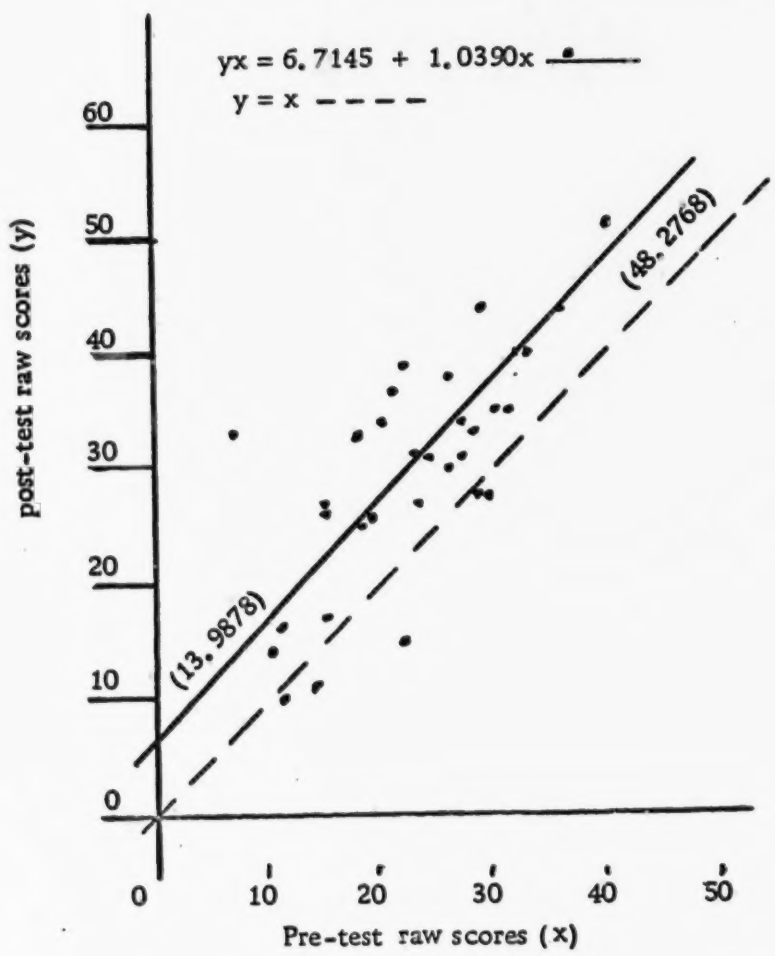


Figure 1. Regression line, vocabulary -

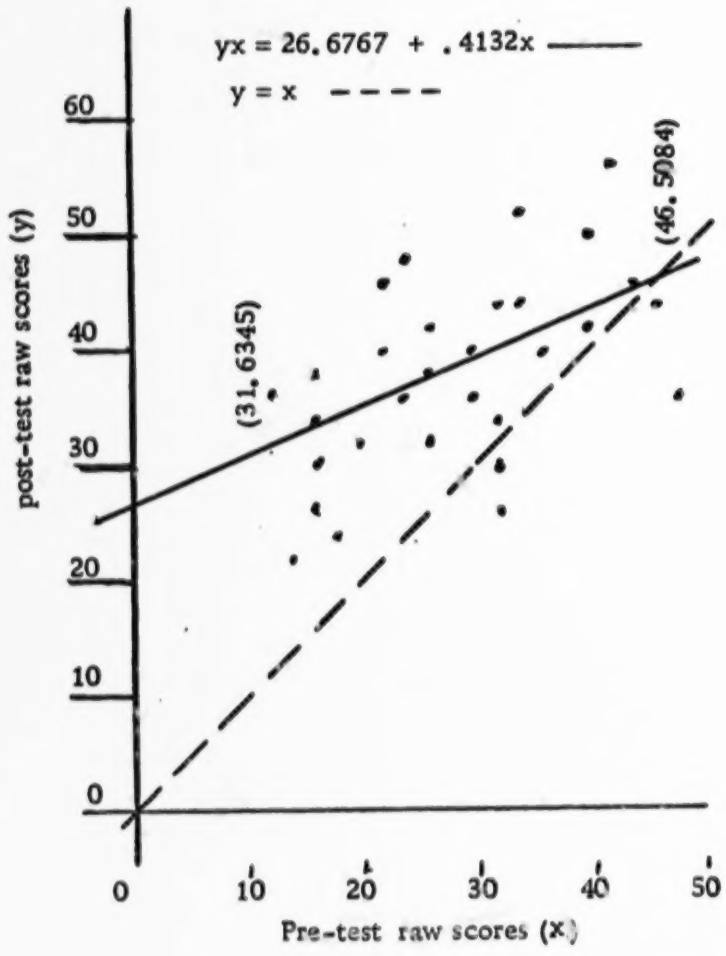


Figure 2. Regression line, comprehension -

Table 2 continued

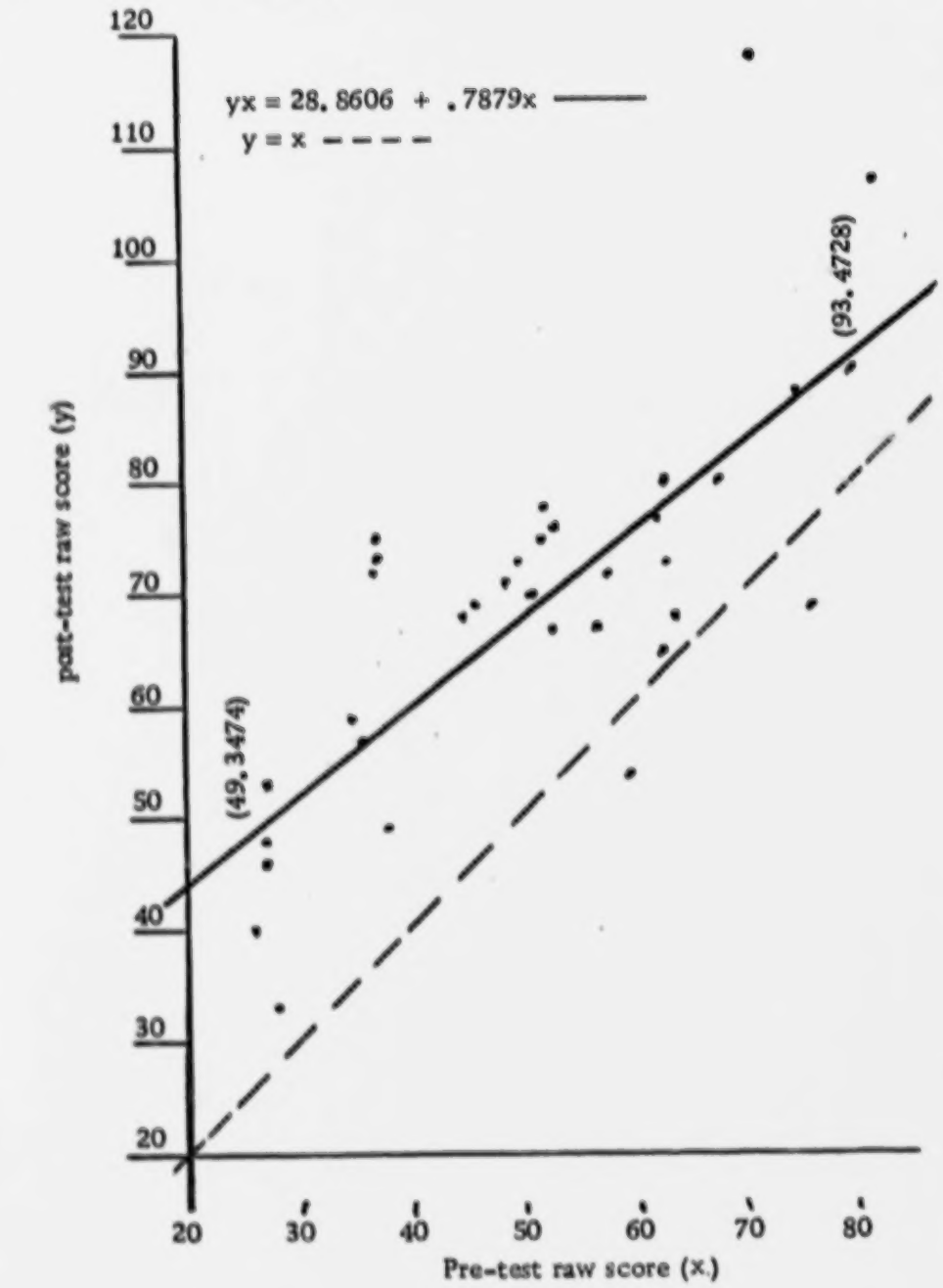


Figure 3. Regression line, total reading -

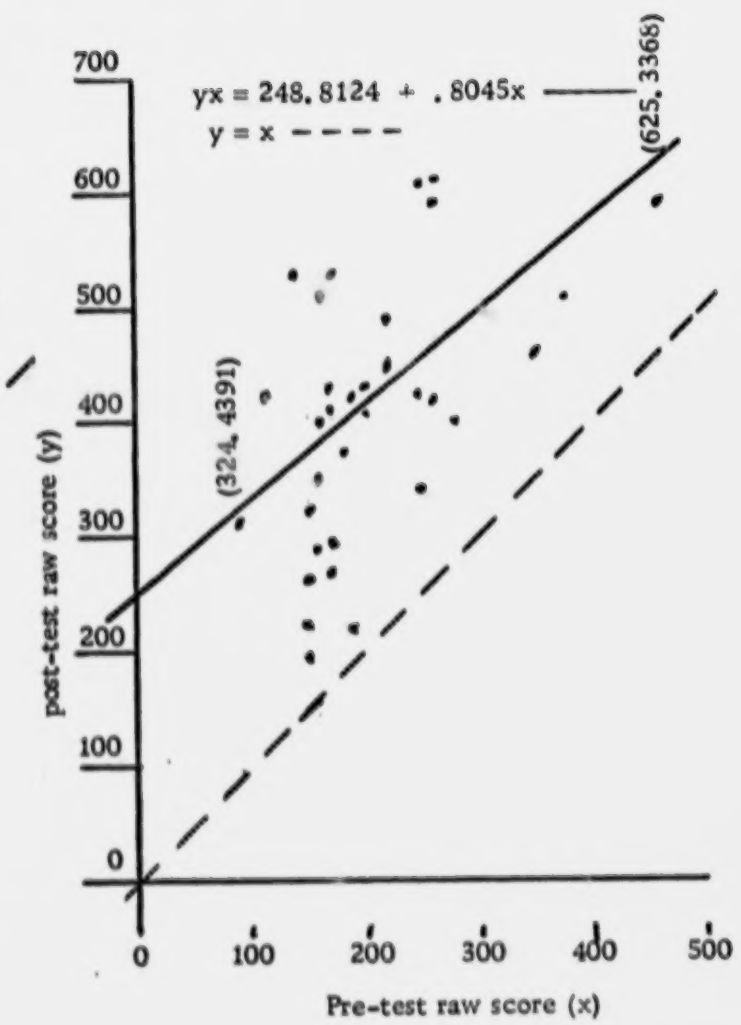


Figure 4. Regression line, reading rate -

on the graph above the zero line; no learning progress is indicated by ±0 and with its position directly on the zero line; and failure of improvement is marked by a minus sign before the crude gain number and with its position below the zero line.

The graphical method of the residual gain procedure shows the regression line determined by its intercept and its slope. At any given value of X, the hight of the regression line tells the average value of Y. Based onthe linear regression formula Y= a + bx, where x is zero, y is equal to a which indicates where the line intercepts the Y=axis, and b, the slope or regression coefficient, indicates how much Y changes with a unit change in x. A student's residual gain is found by locating the intersecting lines on the graph for the student's X and Y scores. The meeting point of the intersecting lines falls either on or above or below the regression line. If the point which represents the student's performance falls directly on the line, the student has performed as predicted. If the point falls above the regression line, the distance between its position and the regression line indicates that the student's performance was higher than predicted on the basis of the pre-test score and a plus sign precedes the residual gain score. If the point falls below the regeression line, the distance between its position and the regression line indicates that the student's performance was lower than predicted on the basis of his pre-test scores and a minus sign precedes his residual gain score. Thus, a minus sign does not spell failure of improvement, but tellsd that the student did not yet improve as much as was expected upon prediction.

For instance, student No. 7 in Table 1 received a pre-course vocabulary raw score of 18 and a post-course raw score of 33 which denotes a crude gain of +15. When considering the same pre-and post-test raw scores his gain as predicted was +7.582 uhits above the regression line as shown in Table2, Fig.1.

The same student's performance in comprehension showed a crude gain of +6 units but according to prediction fall further behind by -10.113 units

(Table 1). In relationship to the regression line he placed below as shown in Table 2, Fig.2. In total reading his improvement in crude gain was +21 units, but when measured by the residual gain procedure the same total reading performance was by -.226 units (Table 1) lower than it should have been according to prediction and his performance placed therefore below the regression line(Table 2,Fig.3). The crude gain in his reading rate performance was +194 units, while the residual gain upon prediction indicated -18.652 units (Table 1) below the regression line (Table 2,Fig.4). In conclusion, the student's No.7 performances in comprehension, total reading, and reading rate have not improved to the degree as they were predicted on the basis of final on initial scores.

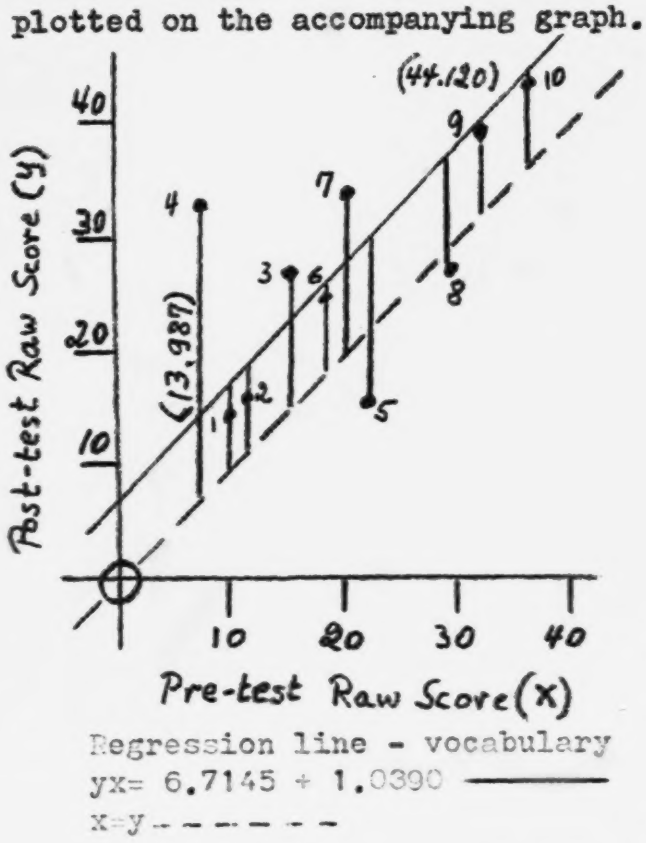
Contrasting the student's residual gains with the crude gains (Table 1, No.7), it appears that his crude gain assessment denotes substantial but erroneous overestimation of his reading advancement.

Crude gain versus residual gain

To analyze the effects of crude gain and residual gain on differences in individual proficiency the reading performances in vocabulary of ten college freshmen were selected from Table 1. These results are listed in the following table(Table 3) and are plotted on the accompanying graph.

Table 3

No.on graph	No.in Table1	Crude gain	Residual gain
1	1	+ 4	- 3.105
2	2	+ 5	- 2.144
3	6	+12	+ 4.699
4	8	+26	+19.012
5	11	- 7	-14.573
6	12	+ 7	- .417
7	18	+14	+ 6.504
8	20	- 1	- 8.847
9	31	+ 8	+ .035
10	35	+ 8	- .120



Regression line - vocabulary
yx= 6.7145 + 1.0390 ——————
x=y - - - - - - -

At inspection of Table 3 the numerical units of crude gain with those of residual gain are compared. The graph shows the crude gain units in relationship to the zero line as well as the residual gain units in relationship to the regression line. To assess crude gain or residual gain units on the graph, it is necessary to count either upward or downward from the zero line or the regression line.

What message do the results of crude gain compared with the results of residual gain convey to the reading instructor in regard to the student's individual reading improvement? In eight cases out of ten crude gain tended to overestimate individual reading proficiency and in two cases tended to underestimate individual reading proficiency. In the eight cases with the exception of but two -No.5 and 8- crude gains indicated that each student has advanced further in his reading proficiency than he actually did, while in the remaining two cases crude gains indicated that each student has fallen less behind in his reading proficiency than he actually did on prediction of residual gains.

Further investigation of the effects of crude gain and residual gain, shows a comparison of four comprehension scores in Table 4.

Table 4

No.in Table 1	Crude Gain	Residual gain
1	+10	-7.287
8	+10	+ .928
25	+10	+3.275
30	+10	+6.796

Relying on crude gain results each student appears to have made the same amount of pregress expressed in units and therefore may receive the same grade designation of, for instance, B. Examing, however, the residual gains upon prediction of the same four comppehension scores, the individual gain units appear to be different from the apparent uniform crude gain units. Applying grade designations in accordance with the residual gains student No.1 may receive a D, student No.2 a C, while students No.3 and 4 may

receive a B and an A respectively.

Comparing student performances of crude gain with residual gain in total reading, six comparisons are demonstrated in Table 5.

Table 5

No.in Table 1	Crude gain	Residual gain
3	+21	-2.135
7	+21	- .226
13	+23	+3.681
16	+23	+4.741
19	+23	+5.165
20	+23	+5.377

Crude gain of +21 units for students No.3 and 7 seems to overestimate again individual proficiency in total reading by +18.865 units and by +20.774 units respectively. Residual gain procedure instead seems to warn the reading instructor that the reading performances of students No.3 and 7 have apparently fallen further behind by -2.135 units and by -.226 units in each case and that the two students have not achieved as predicted.

The following four scores in Table 5 show a crude gain of +23 units. While each student's performance in total reading appears to be equal to the other when measured by the crude gain method,no such equal appearance of gain can be claimed when the individual total reading improvement is evaluated in the light of the residual gain procedure. According to crude gain measurement, students who started out with lower pre-test scores tended to improve as much as or more than those students with higher initial scores. Measuring, however, total reading improvement by the residual gain procedure a more realistic and reliable advancement is the answer. Students who started with a higher initial status tended to improve in accordance with their own individual proficiency, because residual gain is the deviation of final scores from the regression line of final on initial scores.

Summary

The comparison of the effects of crude gain with those of residual gain in individual reading improvement as measured on the Nelson-Denny

Reading Test, Revised, Form A and B, in vocabulary, comprehension, total reading, and reading rate may permit the following conclusions to be drawn:

Crude gain tends to

1. overestimate or underestimate individual reading improvement,
2. ignore individual differences in the initial status,
3. give cause to faulty application of grades attached to individual reading performance, and
4. introduce erroneous or fallacious impressions of individual advancement in reading proficiency.

In contrast to the crude gain method of measuring individual gain, residual gain procedure tends

1. to be a more reliable measurement of individual gain in most reading situations,
2. not to affect the measure of gain in spite of initial differences on the pre-test scores,
3. to provide a more realistic basis for attaching grades to individual reading improvement, and
4. to estimate the inferior and the superior improvers in accordance with their own proficiency and progress in the improvement of reading.

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